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Reconstructed Algae-based Membrane Vesicles: Formation, Characterization and Potential Applications

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Marine algae thrive in aquatic ecosystems, play an important ecological role and offer significant biotechnological potential. Despite their widespread use, algae-based materials have recently gained attention as a delivery method. Various approaches have been used, from cells to their fragments and vesicles. Recently, interest in extracellular vesicles released by the physiological or pathological activity of algal cells has been very high, but their application is limited by the low production yield and incomplete understanding of the mechanisms of their formation. The aim of our study is to present an alternative approach to prepare vesicles by self-assembly of fragmented membranes from hypo-osmotically stressed microalgae. These micrometer-sized vesicles were characterized using advanced biophysical techniques combining a top-down and bottom-up strategy to describe complex, puzzle-like structures at the fundamental level and exploit their potential. The morphology, composition and properties of the vesicles were investigated. Our results confirm that vesicles behave in a bio-compatible manner, which is a prerequisite for the development of drug delivery systems, and they have also demonstrated the successful transport of model drugs. This unique membrane system is still largely unexplored and offers significant opportunities for future research and applications.